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THE MAMMALS OF THE TEMPERATE FORESTS OF VOLCÁN SUMACO, ECUADOR

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ABSTRACT

A mammal survey was conducted at 2500 m on the eastern slope of Volcán Sumaco, Napo Province, Ecuador. Volcán Sumaco is located east of the eastern slope of the Andes. The mountain is isolated from the eastern cordillera of the Andes by the Río Cosanga and Río Quijos River Valleys. The ecosystem of the survey area is Temperate Mountain Forest (Sierra 1999). Sherman traps, pitfall traps, and mist nets were used to collect the specimens. Seventeen species of mammals were found from the survey area; of these, thirteen were collected and four more were observed. Among the specimens collected were four species (*Cryptotis equatoris*, *Eptesicus chiriquinus*, *Thomasomys fumeus*, and *Neusticomys monticolus*) that represent significant range records for their species. Moreover, two species (*Anoura fistulata* and *E. chiriquinus*) represent new elevation records for their species in eastern Ecuador. Shannon diversity analyses were performed for the overall bat diversity and compared to other mountain forest locations in Ecuador.

Key words: Andes, Ecuador, mammals, range records, Volcán Sumaco

RESUMEN

Se realizó un inventario de mamíferos a 2500 m en el Volcán Sumaco, Provincia de Napo, Ecuador. El Volcán Sumaco está localizado en la vertiente oriental de los Andes. La montaña es un pico aislado de la Cordillera de los Andes por el valle del Río Cosanga. El área muestreada forma parte del ecosistema de Bosque Montano Siempreverde. Para la captura de especímenes se emplearon trampas Sherman y pitfall, así como redes de neblina. En el donde se realizó el inventario se encontraron diecisiete especies de mamíferos, de las cuáles trece fueron colectadas y cuatro fueron observadas. Estas diecisiete especies representan una aproximación del ensamblaje de pequeños mamíferos de esta zona. Entre las especies colectadas constan cuatro (*Cryptotis equatoris*, *Eptesicus chiriquinus*, *Thomasomys fumeus*, y *Neusticomys monticolus*) que constituyen registros significativos de extensión de rango conocido previamente para sus especies. Adicionalmente, dos especies (*Anoura fistulata* y *E. chiriquinus*) constituyen nuevos

registros altitudinales de estas especies en el oriente del Ecuador. Se llevaron a cabo análisis de Shanon para evaluar la diversidad total de murciélagos. La diversidad de murciélagos fue comparada con la de otras localidades de bosque nublado previamente reportadas.

Palabras clave: Andes, Ecuador, extensión de rango, mamíferos, Volcán Sumaco

INTRODUCTION

Volcán Sumaco is an isolated peak of the Cordillera Oriental separated by the lowland valley of the Río Cosanga and Río Quijos (Voss 2003). Volcán Sumaco is located east of the eastern slope of the Andes, on the border of Napo Province and Orellana Province, about 105 km east and 20 km south of Quito, Pichincha Province, Ecuador (Fig. 1). The location and geography of this volcano represents a disjunct pattern between the upper slope populations from mountain forest of the eastern Andes and the main range of the Cordillera Oriental.

Volcán Sumaco has not been surveyed on the upper slopes in 83 years (Anthony 1926). A collection was made by Olalla e Hijos on 10 June 1924 yet the

elevation for this study was not certain, although it may have been between 2440 and 2740 m (Anthony 1926). The justification of this study was best presented by Voss (2003) who stated that populations of mountain organisms on the upper slopes of Sumaco are likely to be ecologically disjunct. The few trails and difficult hiking conditions in the area have contributed to the lack of biological inventory.

Our objective was to investigate the mammals from the temperate forest of Volcán Sumaco to increase the knowledge of the diversity in the region. We report new range and elevation records in this study, which we suggest are due to the lack of sampling in this area.

MATERIALS AND METHODS

This study was conducted from 24 July to 6 August 2007. Our study site was on the eastern slope of Volcán Sumaco at 0°34'19"S, 77°35'64"W (Fig. 1). The surveyed ecosystem is Temperate Mountain Forest of the eastern Andes (Sierra 1999; Ridgely and Greenfield 2001). This mountain is a steep volcanic cone, ringed in scalloped slopes. The forest at 2500 m is mostly hardwood trees with epiphytic plants including mosses. From about 1800 m up to 2700 m bamboo is common. The ridge trails on the eastern slope of Volcán Sumaco are dominated with species from the families Araceae, Bromeliaceae, Cyatheaceae, Ericaceae, Fabaceae, Lobeliaceae, Polypodiaceae, and Rubiaceae.

Sherman traps were set along hiking trails on the forest floor, in trees, in streams, and on stream banks for 1300 trap nights. Bats were caught using mist nets over hiking trails. Pitfall traps were set in the forests along fallen logs for 130 trap nights. Tomahawk traps were

used for 78 trap nights. All voucher specimens (skins, skulls, and skeletons) were deposited in the Abilene Christian University Natural History Collection (ACUNHC) and Sección Mastozoología - Museo de Zoología Pontificia Universidad Católica del Ecuador (QCAZ). The ACUNHC is accredited by the American Society of Mammalogists and QCAZ is recognized by Ecuadorian law. All frozen tissues collected from the survey are deposited in the ACUNHC and QCAZ. To evaluate the species diversity a Shannon Index was calculated using the formula $H^p = -\sum f_i \log f_i / n$ for the purpose of comparing the bat diversity of the locations surveyed in this study with other cloud forest sites (Shannon 1948).

The records and the identifications of the mammals presented in this paper were verified against specimens in the QCAZ and the American Museum of Natural History. Wilson and Reeder (2005) was

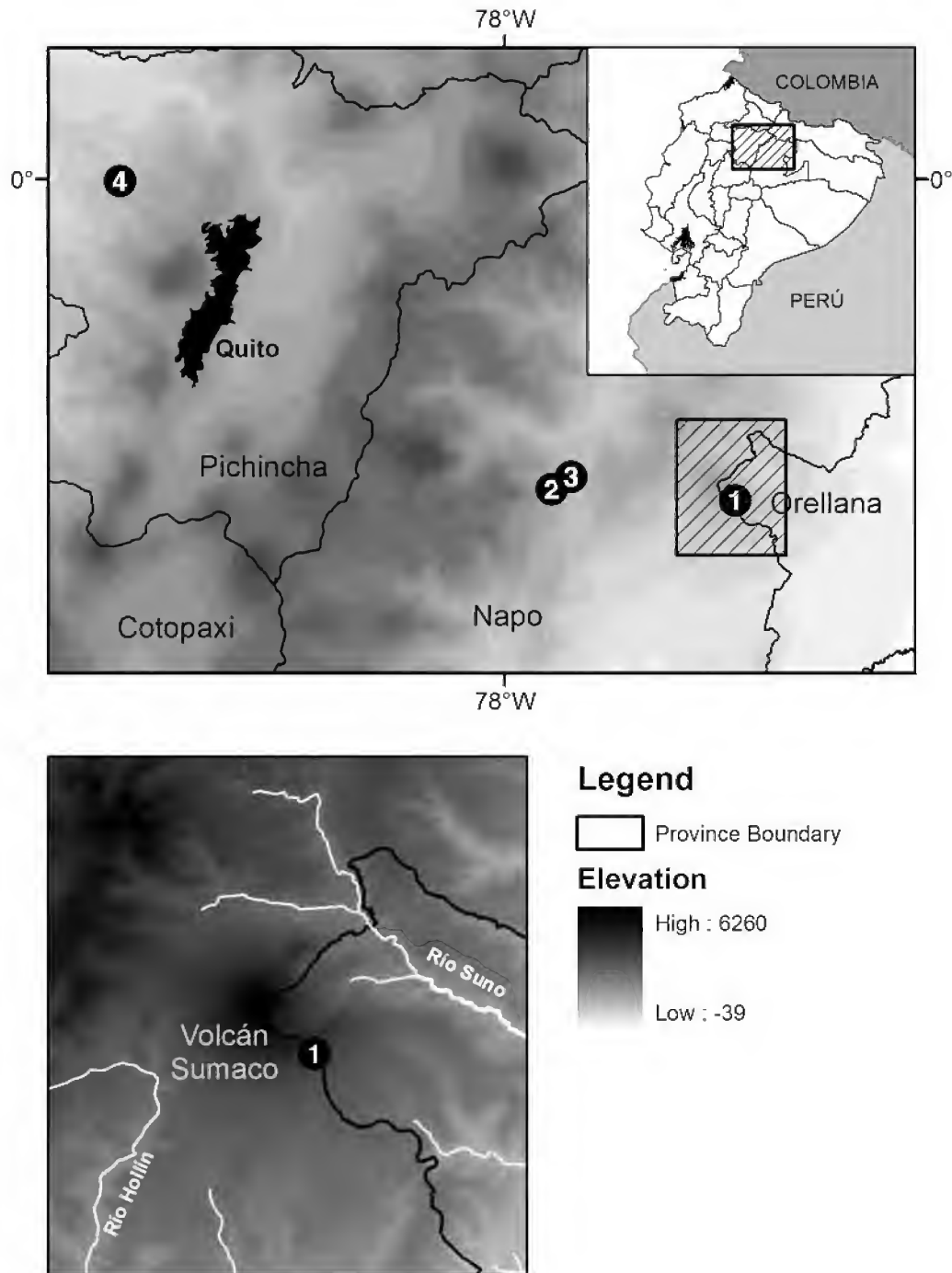


Figure 1. The location of the study site (Volcán Sumaco) designated by the number 1. The study site was on the eastern slope of Volcán Sumaco at $0^{\circ}34'19''\text{S}$, $77^{\circ}35'64''\text{W}$ (see inset map). Locations 2 ($0^{\circ}33'00''\text{S}$, $77^{\circ}55'00''\text{W}$) and 3 ($0^{\circ}31'70''\text{S}$, $77^{\circ}52'99''\text{W}$) are the Casanga River Valley sites. Location 4 is the Tandayapa Valley ($0^{\circ}00'13''\text{N}$, $78^{\circ}40'70''\text{W}$).

used for the nomenclature except for *Anoura fistulata* and *Thomasomys fumeus*. *Anoura fistulata* was recently recognized as a species (Muchhala et al. 2005).

Thomasomys fumeus was recently elevated to species from the subspecies *T. rhoadsi fumeus* (Pacheco 2003; Voss 2003).

SPECIES ACCOUNTS

Presented in these results are a number of new records for Volcán Sumaco. Most of our specimens represent records in either range or elevation that had not previously been reported. The survey is important because until now there was very little known about the mammals of Volcán Sumaco above 1500 m (Anthony 1926; Voss 1988, 2003; Albuja 1999; Jarrin-V 2003; Pozo and Trujillo 2004; Tirira 2007).

ORDER SORICOMORPHA

Family Soricidae

Cryptotis equatoris (Thomas 1912)

Ecuadorian Small-eared Shrew

Four specimens, two males and two females (ACUNHC 1337, 1338, QCAZ 8935, 8946), were collected in pitfall traps that were set next to logs. Three of the shrews were caught in a low area (or the saddle of a ridge of Volcán Sumaco) where the vegetation was very dense. The fourth was caught on a high ridge above a crater lake on the mountain. All of the specimens had uniform dark gray dorsal and ventral pelage and the tail length is 35 to 48% of head/body (Vivar et al. 1997). In comparison *C. montivagus* has pelage that is light grayish brown with the ventral fur slightly paler (Vivar et al. 1997). The basic measurement ranges for these specimens are: total length: 99-114 mm; tail 29-33 mm; hind foot 13-15 mm; ear 3-4 mm; and weight 6-9.5 g. Some selected cranial measurement ranges are: condylo-incisive length 20.9-21.3 mm; breadth of braincase 9.8-10.0 mm; breadth of the occipital condyles 6.1-6.3 mm; length of maxillary tooth row 7.5-7.9 mm; least interorbital breadth 5.1-5.3 mm. These specimens are the first records for *Cryptotis equatoris* on Volcán Sumaco (Eisenberg and Redford 1999; Tirira 2007). This species was recently collected from the Cosanga River drainage 35 km to the west of Volcán Sumaco (Lee et al. 2006b). These specimens were found well within the elevation range for the species (Tirira 2007).

ORDER CHIROPTERA

Family Phyllostomidae

Anoura caudifer (E. Geoffroy 1818)

Tailed Tailless Bat

Four *Anoura caudifer*, three males and one female (ACUNHC 1351, 1354, QCAZ 8916, 8931), were collected in mist nets set over trails. These specimens range in total length from 63-64 mm; tail 0-3 mm; hind foot 10-12 mm; ear 12-13 mm; forearm length 34-37 mm; and weight 8.5-10g. At 2500 m in elevation they are near the record high elevation for the species of 2950 m (Tirira 2007). These specimens of *Anoura caudifer* are the first from Volcán Sumaco. All specimens had a complete zygomatic arch that distinguishes this species from *A. geoffroyi*, forearm less than 37 mm which separates them from *A. cultrata*, and cranial length less than 23 mm which separates them from *A. fistulata* (Muchhala et al. 2005; Mantilla-Meluk and Baker 2006).

Anoura fistulata

Muchhala, Mena-V., and Albuja-V. 2005

Tube-lipped Long-tongued Bat

One specimen (ACUNHC 1352), a male, was collected along a trail. This location is 35 km east of where this species has been taken before (Muchhala et al. 2005; Lee et al. 2006b). At 2500 m this specimen represents a high elevation record, which was previously 2280 m (Tirira 2007). This species can be distinguished from other *Anoura* by its tube-shaped lower lip (Muchhala et al. 2005). The basic measurements for this specimen are: total length 74 mm; tail 0 mm; hind foot 11 mm; ear 16 mm; forearm 38 mm; and weight 13g.

Anoura geoffroyi Gray 1838
Geoffroy's Tailless Bat

Six specimens, two males and four females (ACUNHC 1348-1350, QCAZ 8922, 8932, 8945), of *A. geoffroyi* were collected. All of these specimens had an incomplete zygomatic arch which distinguishes *A. geoffroyi* from other *Anoura*. Each of the females had a single embryo that measured from 6 to 12 mm. The range measurements are: total length 66-77 mm; tail 1 mm; hind foot 10-15 mm; ear 12-16.5 mm; forearm 43-47 mm; and weight 13.5-17 g. This location is well within the elevation range for the species (Patterson et al. 1996; Tirira 2007).

Sturnira bidens Thomas 1915
Bidentate Yellow-shouldered Bat

Twenty-eight specimens (ACUNHC 1323, 1324, 1326-1336, QCAZ 8915, 8923, 8925, 8928, 8930, 8936, 8938-8940, 8942, 8944, 8947, 8951-8953) of 11 males and 17 females were netted and represented the most numerous species caught in the study. These specimens were caught at 2500 m which is well within the record elevation range of this species (Patterson et al. 1996; Albuja 1999; Tirira 2007). This species is easy to distinguish from other *Sturnira* because it is the only species with one lower incisor per rami. The basic measurement ranges for these specimens are: total length: 63-76 mm; tail 0; hind foot 10-16 mm; ear 11-21 mm; forearm length 41.5-45 mm; and weight 17-23.5 g. This species has been previously collected at Cosanga 35 km west of Volcán Sumaco (Lee et al. 2006b).

Sturnira erythromos (Tschudi 1844)
Hairy Yellow-shouldered Bat

One female was collected (ACUNHC 1325) at the site. This specimen is dark brown in color with gray underfur. There are records of this species from near our collecting site, and this species was well represented at Cosanga (35 km to the west of Volcán Sumaco). It is within the recorded elevation range for the species (Albuja 1999; Lee et al. 2006b; Patterson et al. 1996; Tirira 2007). This bat has a flat palate, the upper tooth row is arched outward, and the forearm measures 41.5 mm (Giannini and Barquez 2003). The specimen had

the following measurements: total length 76 mm; tail 0; hind foot 11 mm; ear 16 mm; and weight 15 g.

Sturnira oporaphilum (Tschudi 1844)
Tschudi's Yellow-shouldered Bat

One male (QCAZ 8976) was caught at 0°36'87"S, 77°35'45"W. There are records near our sites for this species (Lee et al. 2006b). This specimen was collected at 1940 m which is well within limits of their elevation range (Tirira 2007). Usually these specimens have a forearm greater than 45 mm. However, in some sub-adults the forearm is as short as 42 mm. This specimen had a forearm of 42.5 mm. When the forearm is less than 45 mm the depression of the palate (or lack of) can be used to identify the species (Giannini and Barquez 2003). This specimen had a strongly depressed palate and had the following measurements: total length 72 mm; tail 0 mm; hind foot 11 mm; ear 15 mm; and weight 21 g.

Family Vespertilionidae
Eptesicus chiriquinus Thomas 1920
Chiriquinan Serotine

Only one male (QCAZ 8914) measured: total length 108 mm; tail 45 mm; hindfoot 11 mm; ear 14 mm; forearm 42.5 mm; and weight 8.5 g. This specimen had a skull length of 16.3 mm, dark brown dorsal pelage measuring 8-10 mm in length, and a well developed sagittal crest. The pelage length separates this species from *E. brasiliensis* and the presence of both sagittal and nuchal crests separates our specimen from *E. andinus* (Simmons and Voss 1998). The bat was collected along a high ridge trail above a volcanic crater lake. The species has been found between 1100 m and 1800 m so this specimen represents an elevation record at 2500 m (Tirira 2007). This is the first record for this species on Volcán Sumaco (Tirira 2007).

Myotis keaysi J. A. Allen 1914
Hairy-legged Myotis

Five specimens, four males and one female (ACUNHC 1346, 1347, QCAZ 8926, 8929, 8934), were collected. The female had one embryo of 11 mm

in length. All of the specimens were caught in nets that crossed or were next to trails on the mountain ridge. This species has previously been recorded within 35 km of this area (Albuja 1999; Lee et al. 2006b; Tirira 2007). This location is well within the elevation range for the species (Patterson et al. 1996). The measurements of these specimens are: total length 91-103 mm; tail length 42-49 mm; hind foot 10-12 mm; ear 12-16 mm; forearm 36.5-42.5 mm; and weight 5-8 g.

ORDER RODENTIA

Family Cricetidae

Microrizomys minutus (Tomes 1860)

Montane Colilargo

Five specimens, four males and one female (ACUNHC 1344, 1353 QCAZ 8918-8920), were collected. The specimens of *Microrizomys* that we caught had a sphenofrontal foramen and the trough for the masticatory-buccinator nerve was perforated. *Oligoryzomys* lack the sphenofrontal foramen and the trough is not perforated (Carleton and Musser 1989). *Microrizomys minutus* tail is greater than 145% of the head body length and this character separates it from *M. altissimus*. These specimens were found well within the elevation range and it has been found 35 km to the west in the eastern Andes (Tirira 2007). All were collected on the ridge of a crater lake. The basic measurement ranges are: total length 194-239 mm; tail 115-142 mm; hind foot 24-26 mm; ear 15-16 mm; and weight 9.5-26 g.

Neusticomys monticolus Anthony 1921

Montane Ichthyomyine

One individual, a female (QCAZ 8956), was caught with a Sherman trap that was placed in a small forested mountain stream. The habitat was different than that described by Tate (1931) and Lee et al. (2006a, 2006b) as our specimen was taken by a small stream that had only a trickle of water. The other streams had waterfalls of a meter or more and this stream on Volcán Sumaco had only small steps of about 20-30 cm. There is only one record of this species outside of the Páramo

from the eastern subtropical ecosystem of Ecuador (Lee 2006b). Lee et al. (2006a) documented this species at 1850 m on the west side of the Andes. Voss (1988) and Lee et al. (2006b) documented *N. monticolus* in eastern Ecuador between 1900 m and 3750 m. Specimens collected by Voss (1988) from Ecuador were found in three locations: San Ignacio, Guarumal, and Papallacta. Lee et al. (2006b) collected a specimen 35 km west of Volcán Sumaco near Cosanga. The Volcán Sumaco specimen was found in temperate forest at 2500 m. The measurements for this specimen are: total length 188 mm; tail 97 mm; hind foot 26 mm; ear 8 mm; and weight 16 g.

Thomasomys fumeus Anthony 1924

Smoky Oldfield Mouse

Six females and five males (ACUNHC 1339-1343, QCAZ 8911, 8959, 8960, 8975, 8982, 8983) were collected in forested habitat. All of these specimens had a hind foot length less than 33 mm and the tail was less than 127% of head body length. These characters separate this *T. fumeus* from all other *Thomasomys* from the Cordillera Oriental of Ecuador except *T. rhoadsi* (Voss 2003; Voss pers. comm.). *Thomasomys fumeus* generally has a smaller hind foot than the 28-31 mm range for *T. rhoadsi* (Tirira 2007). The measurements for these specimens are: total length 212-231.5 mm; tail 97-115 mm; hind foot 21-29 mm; ear 11-19 mm; and weight 31-45 g. Some selected cranial measurement ranges are: condylo-incisive length (25.6-28.2 mm); breadth of braincase (13.2-13.7 mm); breadth of the occipital condyles (6.6-7.3 mm); length of maxillary molars (4.5-5.5 mm); least interorbital breadth (5.1-5.6 mm). These specimens represent a major range record. The only previous record is the type location east of Ambato in Tungurahua Province 140 km to the southwest of Volcán Sumaco (Anthony 1924). The Ambato specimens were found at an elevation of 2500 m similar to our specimens. Importantly, these specimens are the first representatives of this species collected since the Tate expedition to Ambato 83 years ago (Anthony 1924). Musser and Carleton (2005) considered *T. fumeus* a synonym of *T. rhoadsi*, however, Pacheco (2003) recognized *T. fumeus* as a valid species.

Thomasomys erro Anthony 1926
Wandering Thomasomys

Three specimens, two females and one male (ACUNHC 1345, QCAZ 8949, 8961), were collected. Volcán Sumaco is the type location for *T. erro* (Anthony 1926). Additional specimens of *T. erro* have been found near Papallacta and in the Cosanga River Valley (Voss 2003; Lee 2006b). These are the first confirmed records for this species from the Temperate Mountain Forests at 2500 m. The type location is thought to have been between 8000 and 9000 feet or 2440–2760 m (Anthony 1926). These specimens have a hind foot of 28 to 34 mm and a rostral tube which together separate *T. erro* from all other *Thomasomys* in the Cordillera Oriental of Ecuador (Voss 2003). Other measurements are total length 285–299 mm, tail 150–163 mm, ear 19–20 mm, and weight 43.5–49 g. The color of the ventral fur in these specimens varies from gray to brown.

Observed Records.—Two color morphs of squirrel (*Sciurus*) were observed but not collected. Two

individual *Sciurus* were seen at the 2500 m site. The color of these individuals consisted of a light gray head and body with an orange red tail that had a black base and black tip. Another *Sciurus* was seen on the mountain at about 1600 m. This animal had a light gray body, however, the dorsal surface of the head was reddish and the tail was red with a black base (but not a black tip). The only squirrel reported from this area is *Sciurus [granatensis] sumaco* that was collected near San José (Hershkovitz 1947). San José is much lower in elevation (400 m) than any site in this study.

We also encountered tapir tracks along many parts of the trail. These tracks almost certainly belonged to mountain tapir (*Tapirus pinchaque*) because of the location, habitat, and elevation. Moreover, a few tracks of spectacled bear (*Tremarctos ornatus*) were found at 2500 m. Red howler monkeys (*Alouatta seniculus*) were heard most evenings of the study period, however, this troop was probably found at 1600 m.

RESULTS AND DISCUSSION

In comparing our trapping methods we found that all the rodents were caught in Sherman traps, all the shrews were caught in pitfalls, and the bats were caught in mist nets. The chiropteran community in the temperate forests of Volcán Sumaco shows lack of diversity compared with other sites in the Ecuadorian Andes because of its high elevation. These comparative sites are Cosanga and Otonga in the eastern Andes and Guajalito and Tandayapa in the western Andes (Jarrín and Fonseca 2001; Lee et al. 2006a, 2006b). These other sites were between 1300 and 2300 m in elevation. In this study eight species of bats (including *S. oporaphilum*, which was caught at 1600 m) were caught at Volcán Sumaco, while Cosanga had 15, Guajalito 16, Otonga 18, and Tandayapa 13 (Jarrín and Fonseca 2001; Lee et al. 2006a, 2006b). The Shannon index of bat diversity for Volcán Sumaco was $H^p = 0.58$ compared with Cosanga ($H^p = 0.82$), Guajalito ($H^p = 1.03$), Otonga ($H^p = 1.02$), and Tandayapa ($H^p = 0.88$). The absolute number of species is comparatively low by the lower number of bat species found. The Shannon index value has been lowered by the dominance of *S. bidens* ($n =$

28) compared with below six for all other species found on Volcán Sumaco (Shannon 1948).

Volcán Sumaco shares 62.5% of its species with Cosanga (the closest site to Volcán Sumaco). Members of the genus *Sturnira* were the most common bats at all five sites. However, the species of *Sturnira* that was most common varied with the site. *Sturnira ludovici* was the most common at Tandayapa and Guajalito. *Sturnira bidens* was the most common at Otonga and Volcán Sumaco. *Sturnira oporaphilum* was abundant at the Cosanga sites. All of these locations have the bat families Phyllostomidae and Vespertilionidae, but only Cosanga and Otonga have molossids represented. In addition, Otonga had one individual emballonurid (Jarrín and Fonseca 2001; Lee et al. 2006a, 2006b).

The terrestrial rodent fauna of Volcán Sumaco differs from that of Tandayapa and Cosanga. First, *Thomasomys* was the most common rodent. Members of the genus *Thomasomys* were found at Cosanga, but they were not common (Lee et al. 2006b). Second,

although the numbers were low, Volcán Sumaco had four rodent taxa compared with three for the Cosanga and Tandayapa locations (Lee et al. 2006a, 2006b).

Although its upper slope ecosystems are isolated, biogeographically Volcán Sumaco is part of the eastern slope of the Andes. This is demonstrated by the presence of *T. erro*, *T. fumeus*, and *S. oporaphilum*. These animals have been found only on the eastern slope of the Andes (Tirira 2007). Both Volcán Sumaco's loca-

tion and its isolation are reflected in ornithological and botanical studies (Robblins and Howell 1995; Løjtnant and Molau 2008).

The long term conservation status of this part of Volcán Sumaco is secure because this area is protected in a national park. People in the towns close to Volcán Sumaco obtain resources from forestry on the lower slopes of the mountain, however, these locations are outside of the park.

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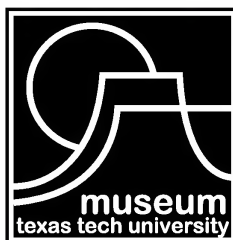
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